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erc

In-Gas Laser ionisation and spectroscopy of actinium isotopes

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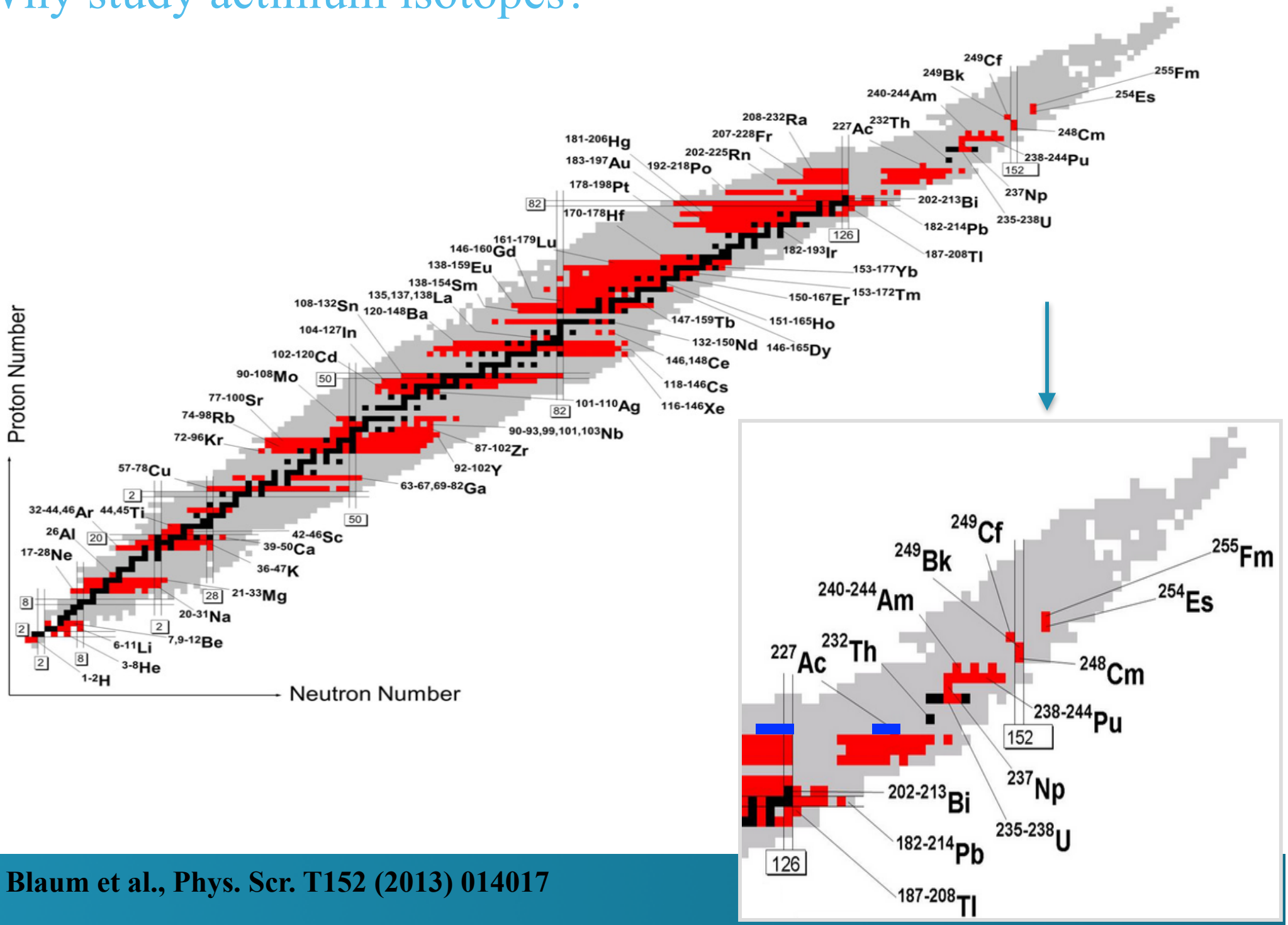
Why study actinium isotopes?



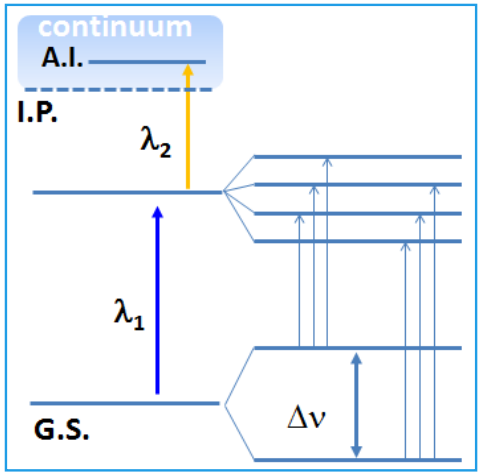
K. Blaum et al., Phys. Scr. T152 (2013) 014017

Outline

1. In-gas laser ionisation spectroscopy at the Leuven Isotope separator on line (LISOL) facility
2. Laser spectroscopy on actinium isotopes
3. In-gas-jet laser ionisation and spectroscopy of ^{214,215}Ac

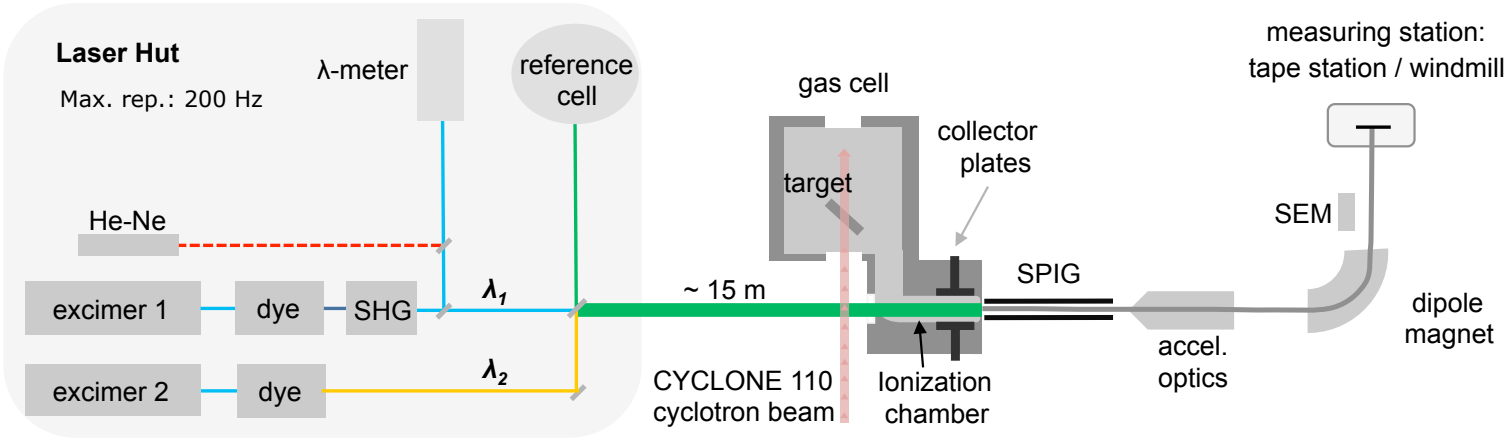
LISOL: 40 years of nice results

What do we study?



Two steps in-gas cell laser ionisation and spectroscopy

Where do we study it?



Results

In-gas-cell spectroscopy of neutron deficient Cu and Ag isotopes

T. E. Cocolios *et al.*, PRL 103, 102501 (2009)
T. E. Cocolios *et al.*, PRC 81, 014314 (2010)
R. Ferrer et al., PLB 728 (2013) 191

Yu. Kudryavtev et al., NIM B 114 (1996) 350
M . Facina et al., NIM B 226 (2004) 401

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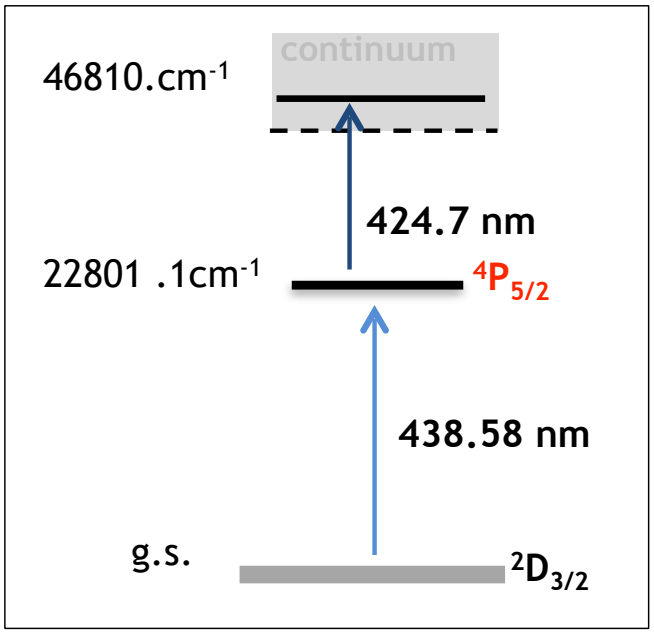
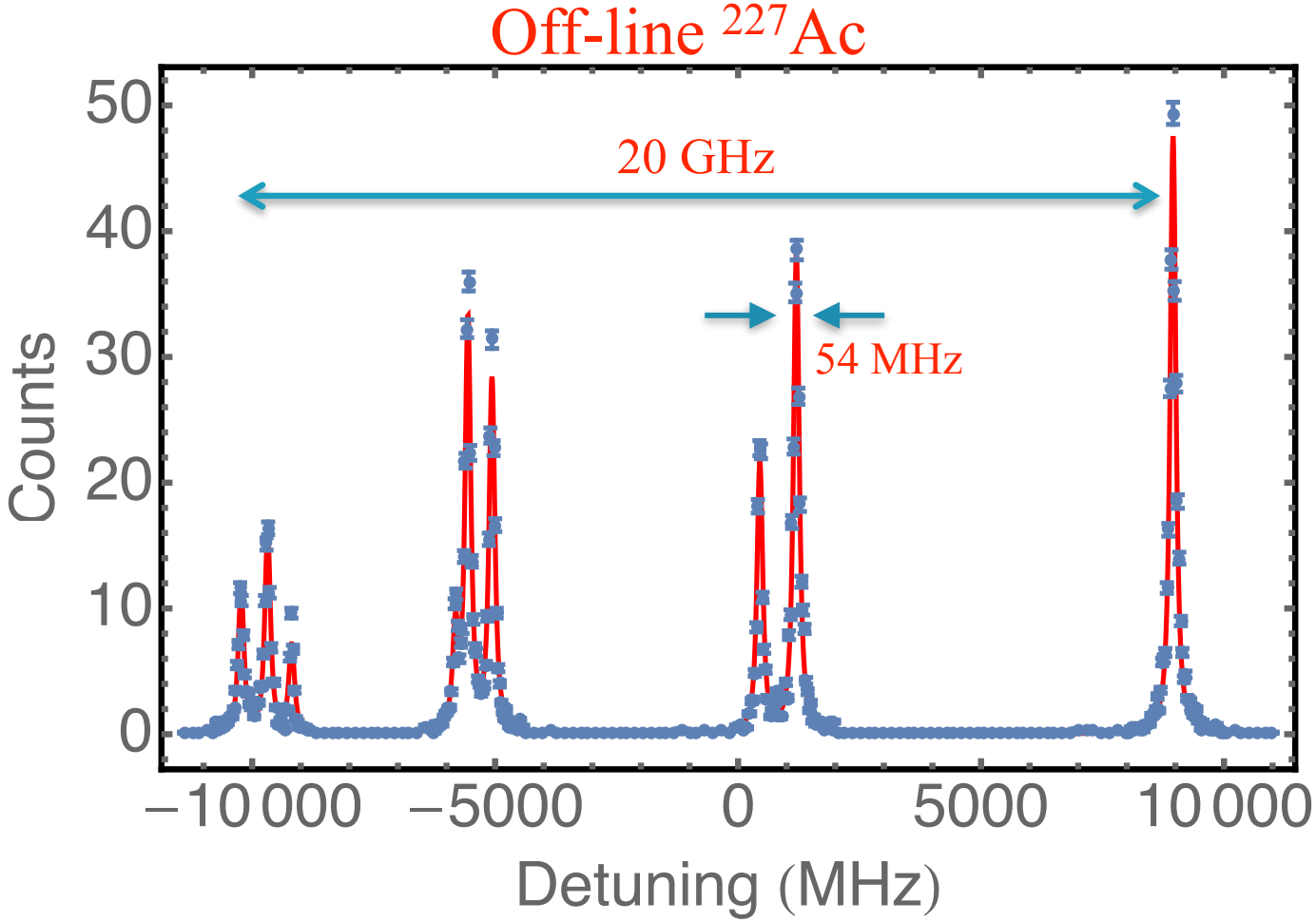
Previous work



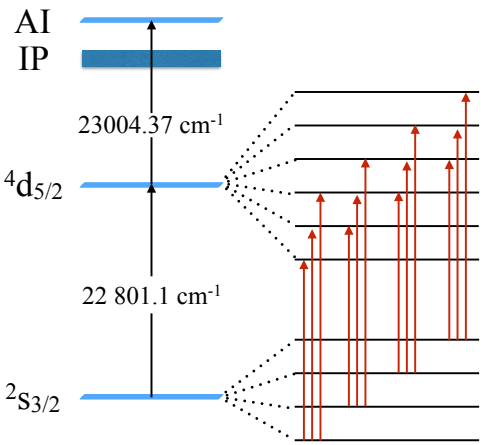
-Large hyperfine splitting
-Well characterised atomic structure.
-Bigger hyperfine splitting for larger spin in neutron deficient actinium isotopes



V. Sonnenschein, (Ph.D. thesis), The University of Jyväskylä, 2015.

Results

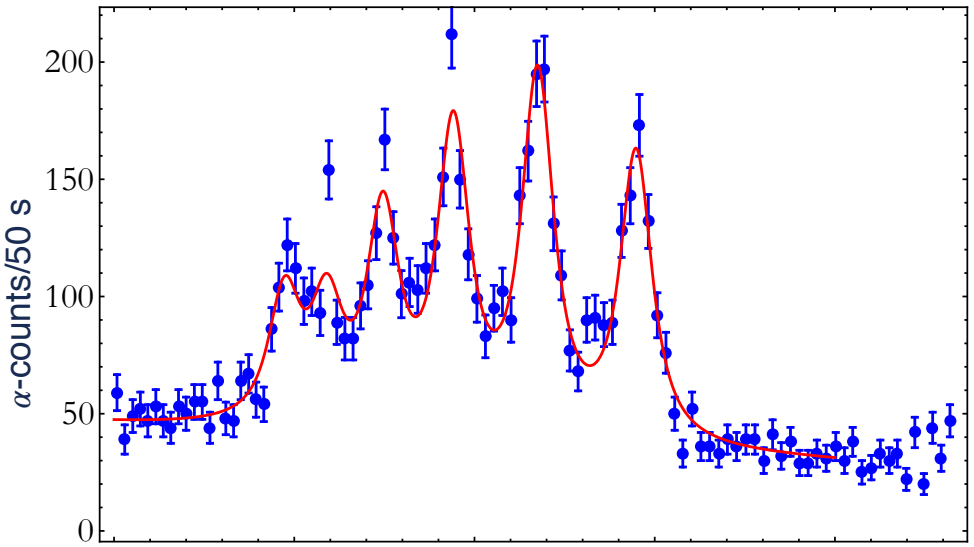
$^{197}Au(^{20}Ne\text{-}145\ MeV,4\text{-}5n)^{212,213}Ac$
$^{197}Au(^{22}Ne\text{-}143\ MeV,4\text{-}5n)^{214,215}Ac$



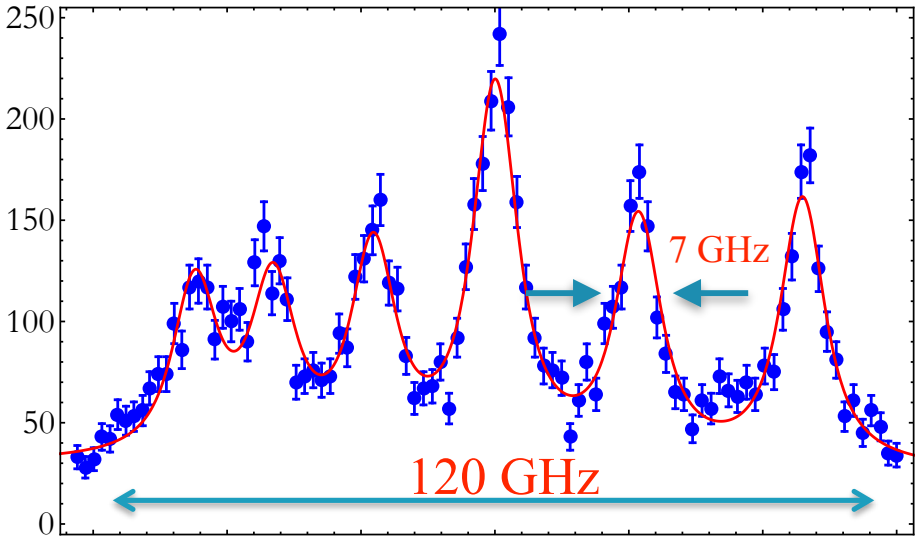
$^{213,215}Ac$ F	^{212}Ac F	^{214}Ac F
7	19/2	15/2
6	17/2	13/2
5	15/2	11/2
4	13/2	9/2
3	11/2	7/2
2	9/2	5/2
6	17/2	13/2
5	15/2	11/2
4	13/2	9/2
3	11/2	7/2

- HFS fitted with the A ratio from ^{227}Ac.
- Nuclear spin from literature.
- Excited state masked by the pressure broadening.
- Fitting performed with a unified python program for the IKS: SATLAS!

215Ac



214Ac



Overal Efficiency ~1%

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Summary

What have we learnt?

1) Indication of nuclear spin for the more neutron deficient isotopes

I(^{215}Ac)=(9/2)

I(^{213}Ac)=(9/2)
I(^{214}Ac)=(5)
I(^{212}Ac)=(7)

2) Dipole moments and isotope shift.

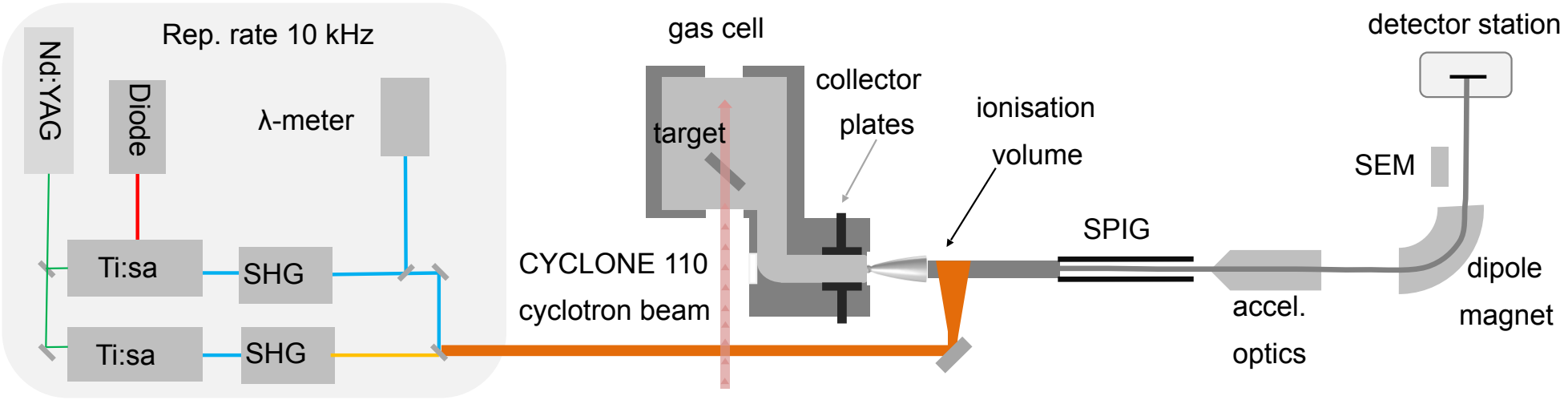
What is missing?

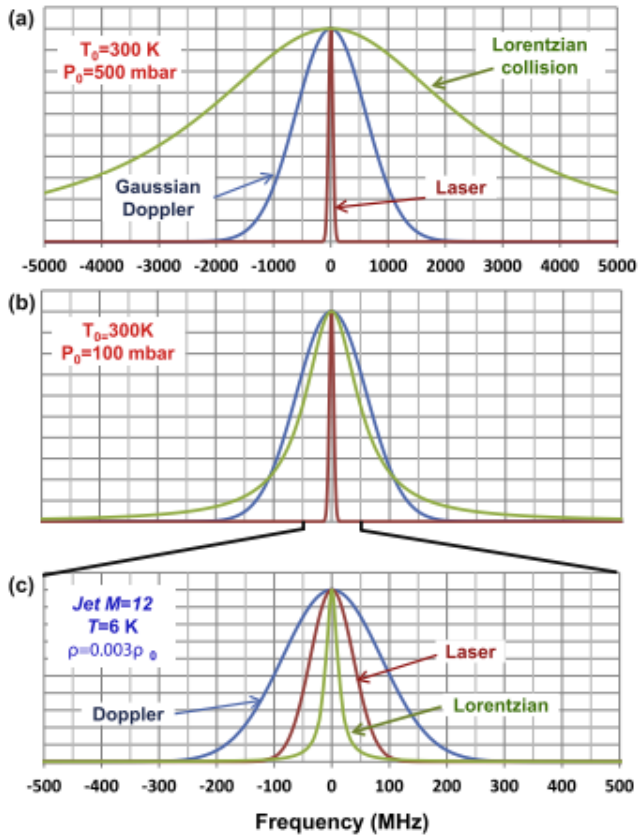
1) Mean charge radii: Calculation of the electronic factors have to be performed (King plot)
2) Quadrupole moments

What do we want?

1) **Developing a new laser spectroscopy technique to minimise the broadening mechanism and to perform high resolution lasers spectroscopy**

In-gas-jet laser ionisation and spectroscopy

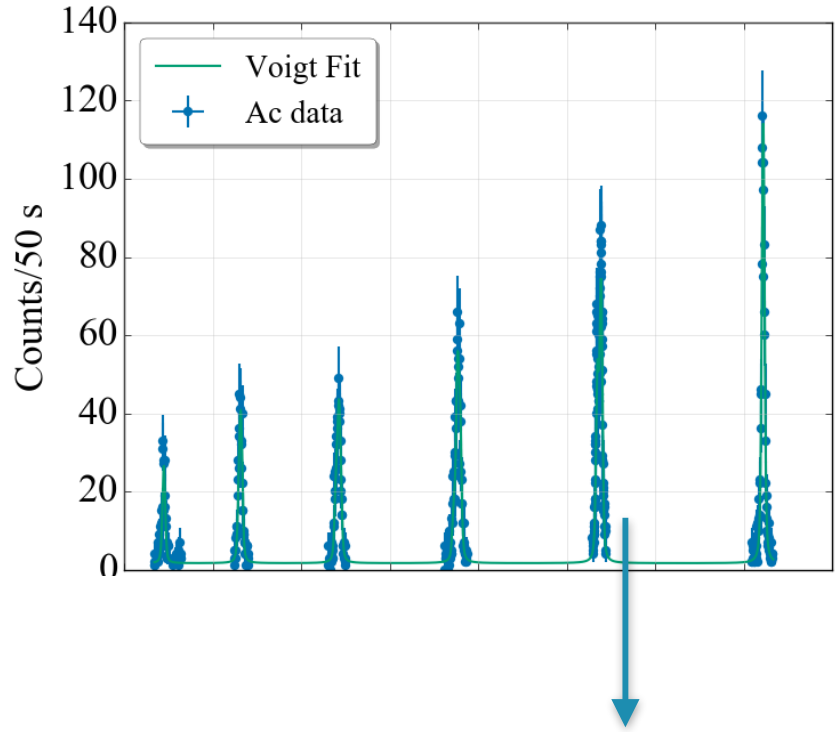




The nature of the jet enables the cancelation of the pressure broadening

Y. Kudryavtsev et al., NIM B 297 (2013) 7–22

Atoms are better served cold



Resolution ~ 5e-7

(FWHM= 400 MHz)

Efficiency ~ 0.5%

And still room to improve: rr of the laser system and divergence of the supersonic jet.

Under investigation in the IGLIS laboratory at KU Leuven.

- Extraction of quadruple moments from the HFS is now possible
- Confirmation of the ground state nuclear spin for ^{214,215}Ac. I=5,9/2 respectively.
- Problem found and solve for the absolute values of the resonances energies when compare the gas-cell and gas-jet spectroscopy

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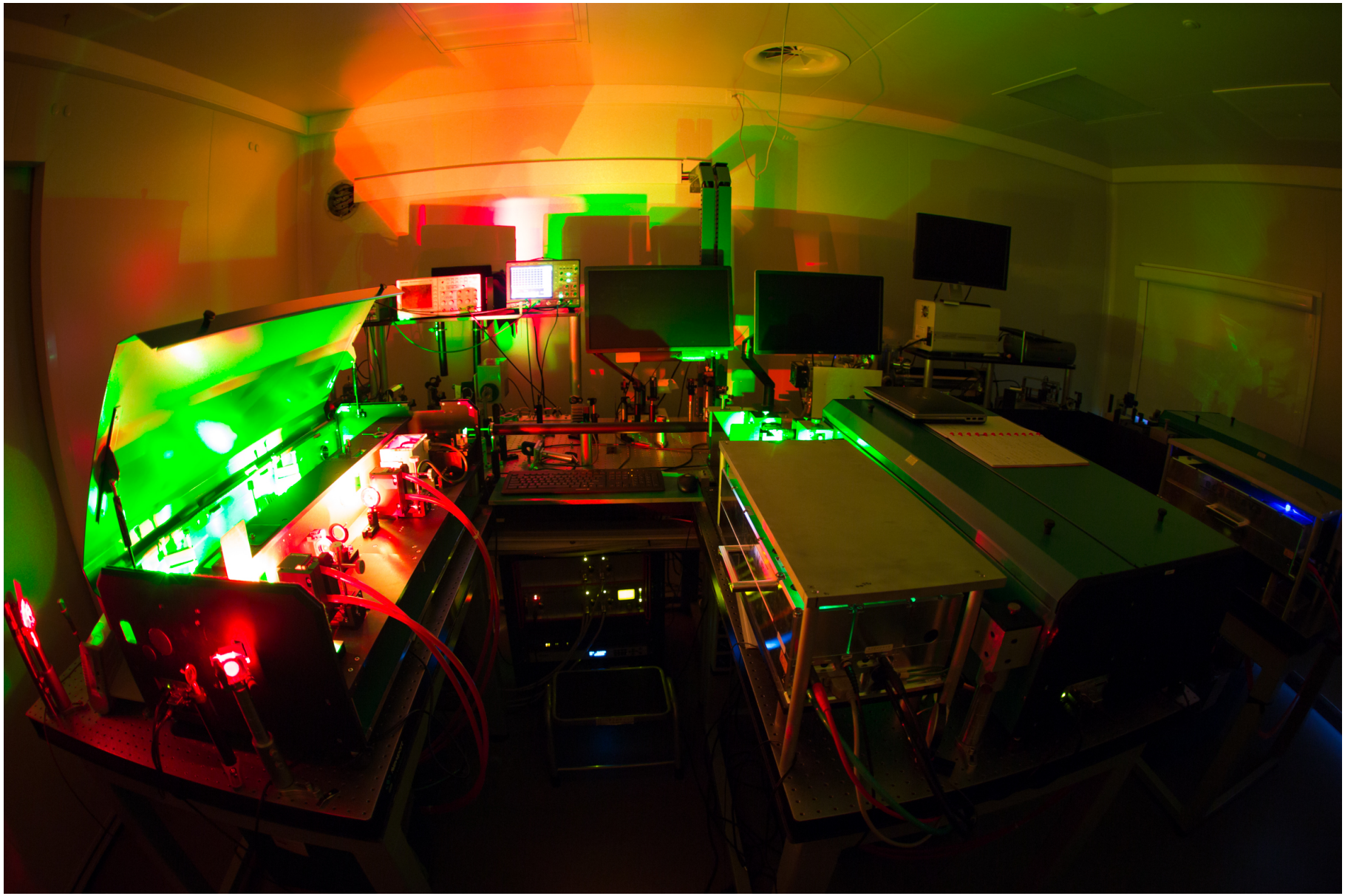
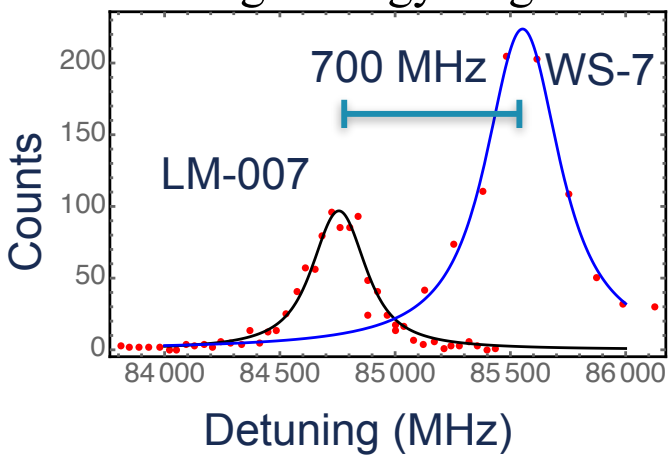
The Heavy Element Laser Ionisation Spectroscopy (HELIOS) project

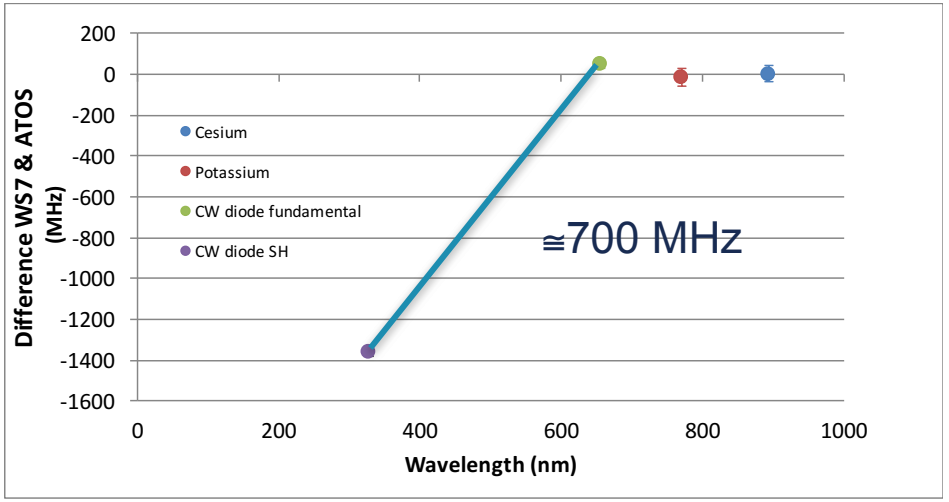


Helios project

LM-007

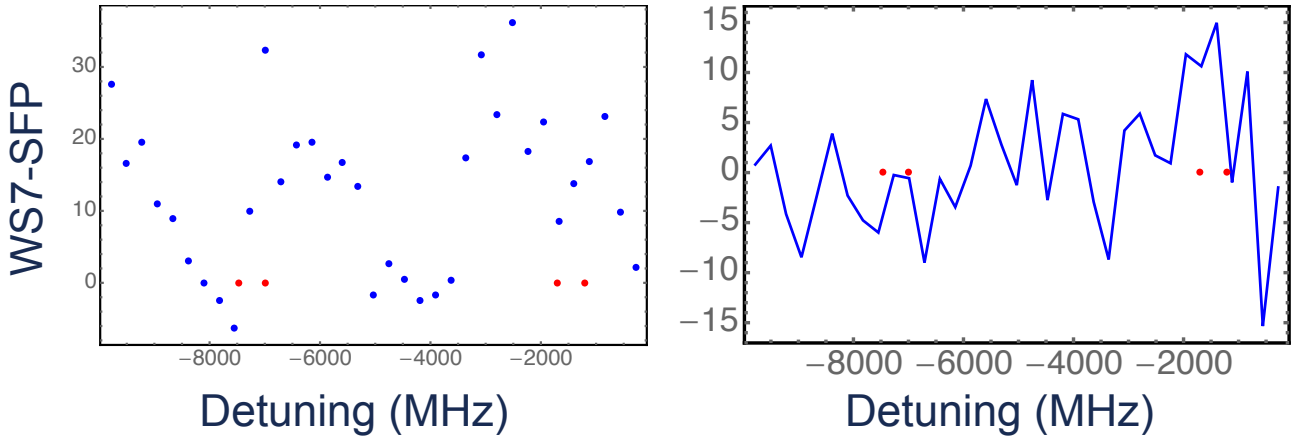
High energy singlet





WS-7

On-going investigation



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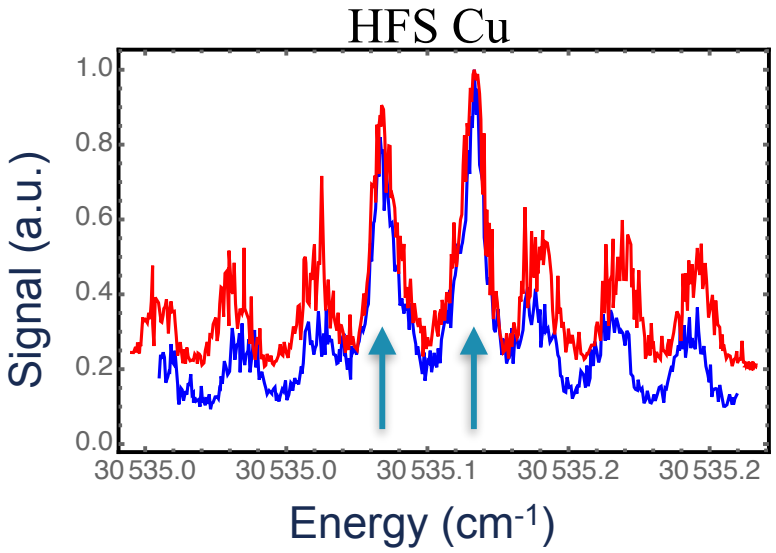
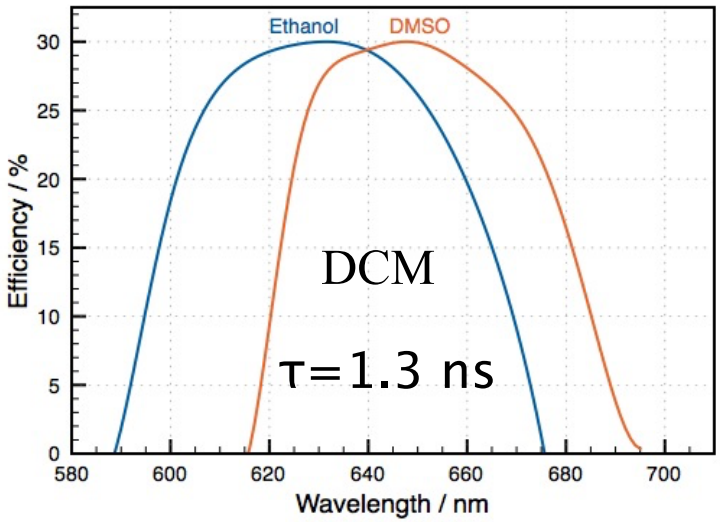
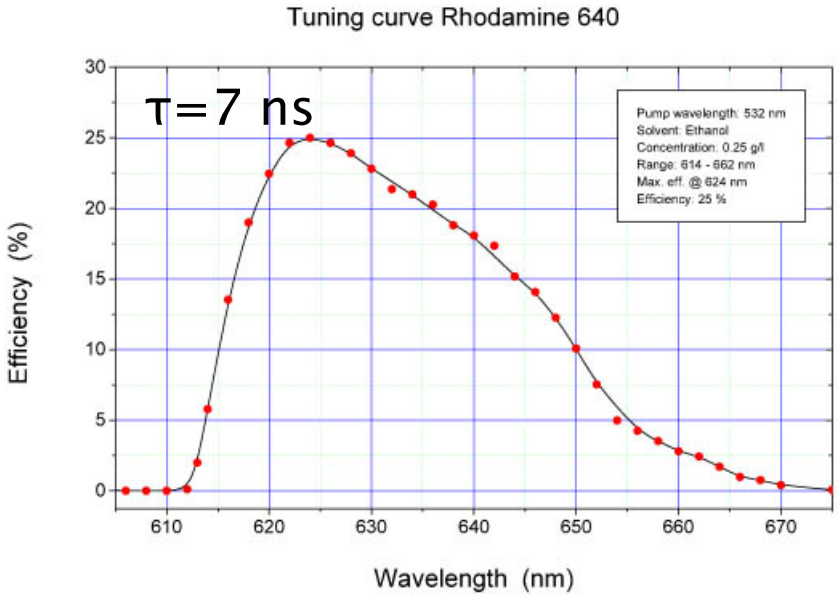
Helios project





Side bands problem. Originating from the combination of the pump Nd:YAG lasers and the life time of the dye excited state.



Under investigation:

- Tuning curve shift if water is added to the solution
- Monitoring of the dye ageing
- New data acquisition system for the laser lab.

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Conclusions

What have we learnt?

1) Characterisation of the capabilities of the in-gas-jet spectroscopy
2) Limits of the spectral resolution of Ac

Next steps

3) Commissioning and characterisation of the in-gas-jet spectroscopy:
    1) Visualisation of the gas-jet formation
    2) Characterisation of the ion guide system
4) Comparison between the reference cell spectroscopy ("ideal" system) and the off-line in-gas-jet spectroscopy
5) Optimisation of the in-gas-jet laser spectroscopy
6) Investigation of super heavy elements at S^3 GANIL / MARA JYFL

KU Leuven team

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AND THANK YOU ALL FOR YOUR ATTENTION

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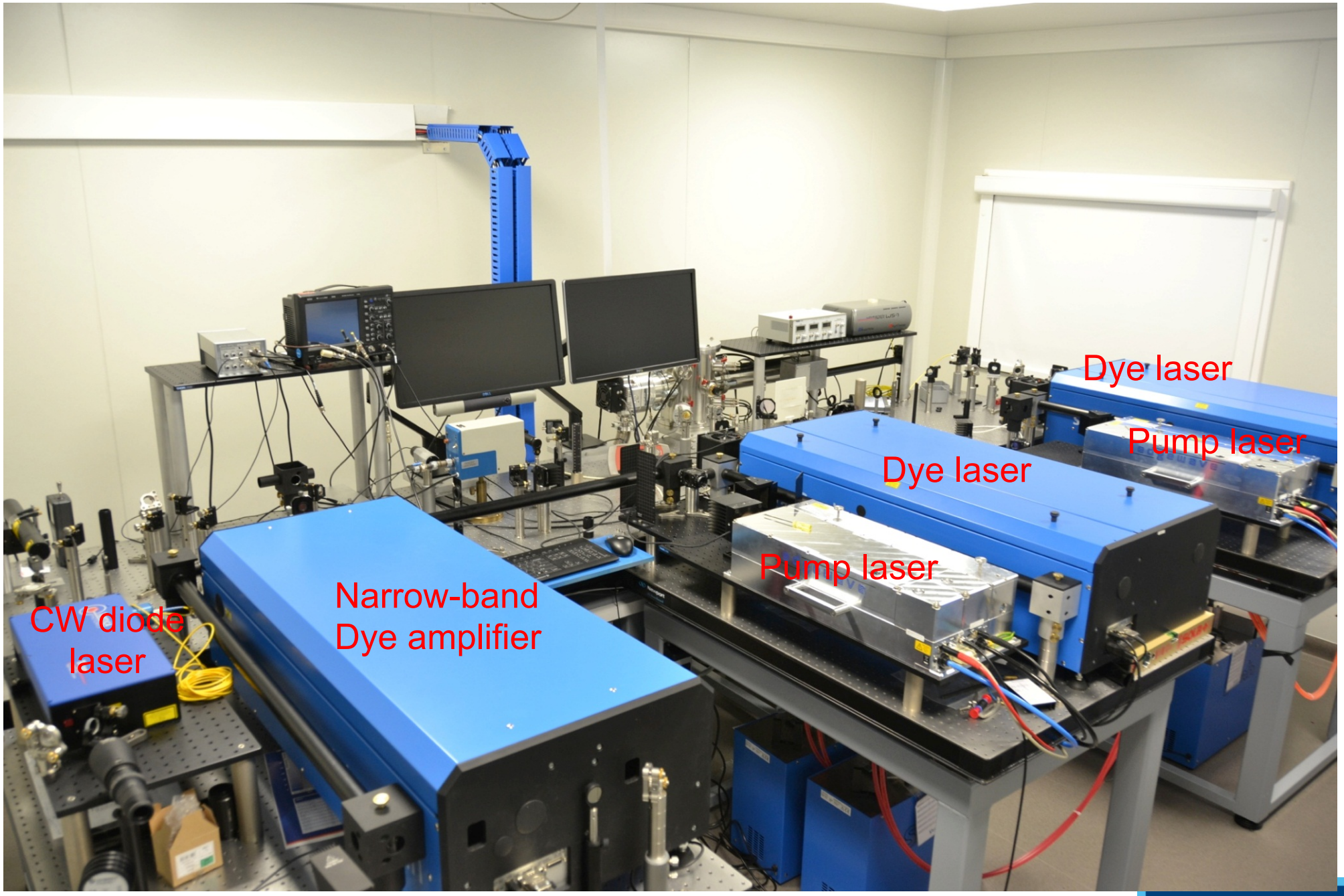
The IGLIS laboratory: Laser room



The IGLIS laboratory: Gas-cell room